# ECE-4074

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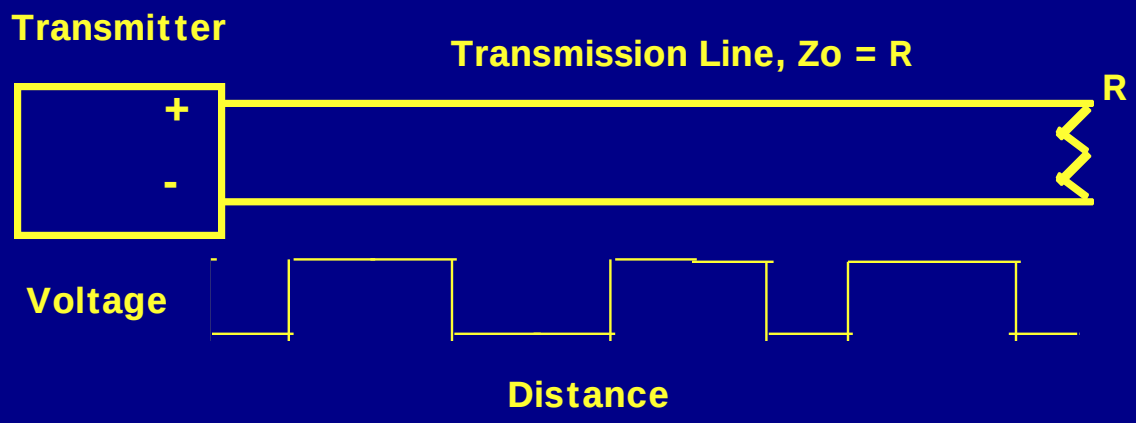
- Framing
- Ratios as Decibels
- Characteristic Impedance
- Scrambling

Appendices 3A-3C, pp 115-120

# Characteristic Impedance

A uniform transmission line will conduct an electrical pulse

- in one direction at a constant speed ( usually ~ 2E8 m/s)
- without reflection if the end is terminated with R = Zo



## Decibels = 10 * log (Ratio)

| Loss factor | Gain factor | Loss factor | Gain factor | Loss factor |
|---|---|---|---|---|
| = .05 | = 100 | = .02 | = 40 | = .01 |
| -13 dB | = 20 dB | = -17 dB | =16 dB | = -20 dB |

Circuit Gain =

.05
x 100
x .02
x 40
x .01
0.04

Circuit Gain =

-13 dB
+20 dB
-17 dB
+16 dB
-20 dB
-14 dB

.05 = 10**-1.3
100 = 10**+2.0
.02 = 10**-1.7
40 = 10**+1.6
.01 = 10 **-2.0

# Decibel Relationships

| Ratio | dB | Quick Calculation |
|---|---|---|
| 1 | 0 | 1 = 10**0 |
| 1.25 | 1 | 1.25 = 5/4 = 7-6 dB |
| 2 | 3 | (5/4)**3 = 125/64 |
| 4 | 6 | 2*2 = 3+3 dB |
| 5 | 7 | 10/2 = 10-3 dB |
| 8 | 9 | 2*2*2 = 3+3+3 dB |
| 10 | 10 | 10**1 |
| 100 | 20 | 10**2 |
| 1000 | 30 | 10**3 |
| 1/R | -D where R -> D | log(1/x) = -log(x) |
| 1+0.25*f | f | f < 1 (fraction) |

**Memorize the ratios corresponding to 1, 3, and 10 dB, and you can quickly calculate the ratio for any dB.**

# Bit-Orient Framing

```
100101111110011010000110010101101100011010001101111110011
```

**A stream of 0's and 1's are received. We know it is text data (characters encoded as 8-bit codes). Where are the first bits of a code?**

**One technique is to use a special 8-bit "flag" code (byte or octet) that contains six "1"s in a row (01111110).**

```
1001 01111110 01001000 01000101 01001100 01001100 01001111 10011
     Start       H        E        L        L        O
```


**The "flags" "frame" the "data". This type of structure is called a "packet", "cell" or "frame" depending on the protocol.**

## Bit Stuffing

**To prevent a flag-like sequence appearing in the data, the following rule is applied when the frame is formed:**

- **After five "1"s in a row, an extra zero is "stuffed" into the bit stream (whether the next bit is a "1" or a "zero").**

**When data is taken out of a frame at the receiving end, the following rule restores the data:**

- **whenever five "1"s in a row appear, the next bit is discarded.**

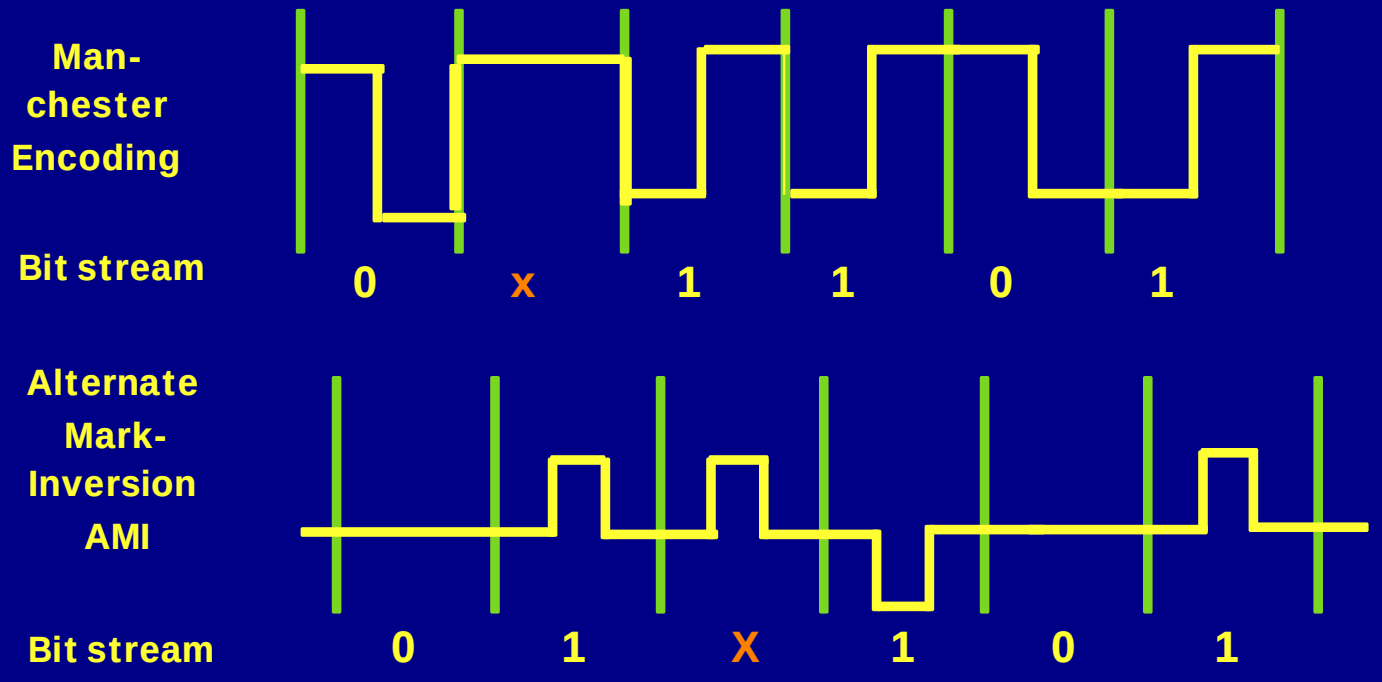
Data: 0110111110110001011111100101000000

Framed Data:

01111110011011111001100010111110100101000000001111110

## Encoding Rule Violation Framing

In some systems, the transmitter will send a signal that violates an encoding rule to signal the start of a frame. Examples:



## Character-Oriented Framing

Some character-oriented protocols need to divide a stream of characters (octets, bytes) into frames. Three codes are used to build frames which are designated:

- "Data Link Escape" or DLE
- "Start Transmission" or STX
- "End Transmission" or ETX

The rules are:

- Frames are started with the two-octets: DLE STX
- Frames are ended with the two octets: DLE ETX

Since all 256 possible 8-bit codes can appear in the data, whenever a DLE octet appears, a second DLE is stuffed into the character stream after it.

```
Data:              A B DLE C D STX F ETX G H
Framed Data:
      DLE STX A B DLE DLE C D STX F ETX G H DLE ETX
```

## Character-Oriented Frame Decode

**Decoding rule: whenever a DLE character appears in the incoming character stream, it is interpreted in combination with the next character according to this table:**

- **DLE STX = Start of Frame (discard, start saving data)**
- **DLE DLE = Replace with single DLE**
- **DLE ETX = End of Frame (discard, pass data to higher level)**
- **DLE [anything else] = coding error.**

```
Framed Data:
      DLE STX A B DLE DLE STX D E F ETX G H DLE ETX
Data:         A B DLE     STX D E F ETX G H
```

## Scramblers

There are problems when long strings of only "0"s or only "1"s are transmitted. To prevent this a scrambler can be used at the transmitter, and a matching descrambler at the receiver.

Scrambler: $B(m) = A(m) \quad B(m-3) \quad B(m-5)$

- where in the "exclusive or"
- A(m) is the m'th bit input
- B(m) is the m'th bit output.

Descrambler: $C(m) = B(m) \quad B(m-3) \quad B(m-5)$

- B(m) is the m'th bit input
- C(m) is the m'th bit output.

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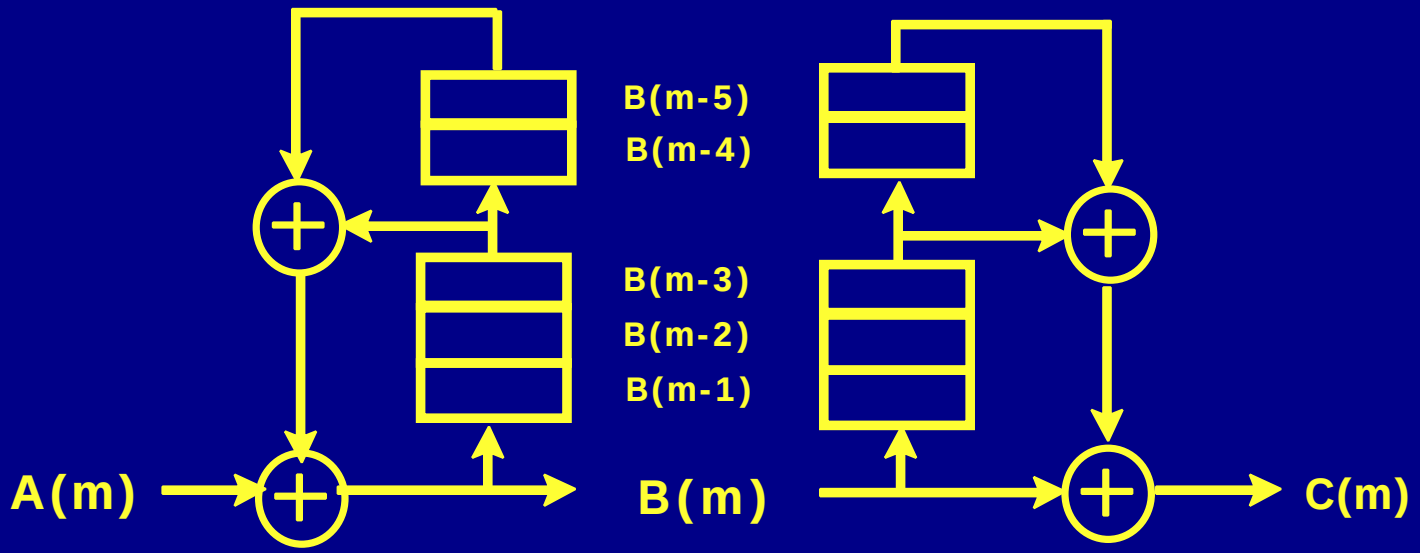
# Shift Register Scramblers

**Scrambler:** $B(m) = A(m) \quad B(m-3) \quad B(m-5)$

**Descrambler:** $C(m) = B(m) \quad B(m-3) \quad B(m-5)$




$C(m) = B(m) \quad B(m-3) \quad B(m-5)$

$C(m) = \{A(m) \quad B(m-3) \quad B(m-5)\} \quad B(m-3) \quad B(m-5)$

$C(m) = A(m)$ since $X \quad X = 0, \quad Y \quad 0 = Y$